

WHITE MOUNTAIN RESEARCH STATION  
UNIVERSITY OF CALIFORNIA, BERKELEY

IN VIVO MEASUREMENT OF HUMAN BODY COMPOSITION

NASA Grant, NGR 05-003-470

SEMI-ANNUAL STATUS REPORT NO. 6

1 January 1975 - 30 June 1975

(NASA-CR-146223) IN VIVO MEASUREMENT OF  
HUMAN BODY COMPOSITION Semiannual Status  
Report, 1 Jan. - 30 Jun. 1975 (California  
Univ.). 67 p HC \$4.50.

CSCL 06B

N76-16748

Unclas  
13554

G3/52



Principal Investigator: Nello Pace

Co-Investigators: Benjamin W. Grunbaum  
Arthur M. Kodama  
David C. Price

Technical Assistant: Edward J. Gorman

Table 61. Summary of percentage changes in urine constituents when expressed as quantity excreted per unit quantity of creatinine excreted on the days of continuous recumbency indicated. The percentages statistically significantly different from the base value of 100% ( $P < 0.05$ ) are indicated by an asterisk.

Constituent	Day 2	Day 6	Day 12-13	Day 19
Osmotic Activity	103.6	100.3	92.5	70.7
Chloride	117.6*	91.9	93.4	53.6
Sodium	110.3	92.9	95.7	65.8
Potassium	96.9	104.3	96.3	59.3
Magnesium	95.8	79.1	76.0	108.8
Calcium	110.5	95.8	115.5	120.8
Phosphate	78.7*	103.1	96.7	91.1
Total Nitrogen	89.7*	94.2	110.8	106.3
Ammonia	98.4	81.7	97.7	125.1*
Urea	87.2*	100.4	126.2	144.4
Creatine	97.1	283.9	98.1	208.8
Hydroxyproline	98.0	74.3	114.1	128.2
Glucose	88.4	78.2	130.8	118.2
Citrate	97.0	110.9	101.2	102.9
17-OH Corticosteroids	121.0	90.4	107.8	87.7
Epinephrine	93.0	59.2	56.0	45.7
Norepinephrine	97.8	76.3	71.2	83.8

# IN VIVO MEASUREMENT OF HUMAN BODY COMPOSITION

During the summer of 1974 investigators from this laboratory collaborated in a bed-rest study conducted in the Human Research Facility of the NASA Ames Research Center. Dr. Harold Sandler, Chief, Biomedical Research Division, NASA Ames Research Center, was the Principal Investigator for the entire study, and Dr. Charles M. Winget, Human Studies Branch, served as the Project Manager.

The study was designed to examine the time course of a number of physiological changes that occur during the first 21 days of continuous bed rest, and involved a total of 14 normal men in the age range of 25 to 36 years. The men were divided into 4 groups, Groups A, B, C, and D, of 3 or 4 men each, and were tested on a staggered schedule in the Human Research Facility.

In each instance, the members of a subject group entered the Human Research Facility and remained ambulatory for 8 days before the bed-rest period was begun, in order to provide base-line physiological information. The 3 men of Group A were scheduled for 3 days of continuous recumbency, the 4 men of Group B for 7 days, the 3 men of Group C for 14 days, and the 4 men of Group D for 21 days.

The schedule was arranged in such a way that our laboratory (UCB) personnel performed base-line tests on all subjects 1 to 2 days before the start of their bed-rest period. The UCB measurements on Group A were repeated on Day 2 of bed rest, and on Group B they were repeated on Day 2 and Day 6. On Group C, the UCB measurements were repeated in 2 of the subjects on Day 6 of bed rest, and in 1 subject on Day 12 of bed rest. On Group D, the UCB measurements were repeated in 3 of the subjects on Day 13 and Day 19 of bed rest. The schedule followed for the UCB measurements is summarized in Table 1.

Table 2 identifies the subjects comprising each of the 4 groups tested, and gives their vital statistics. Table 3 rearranges this same information in terms of the data groupings examined to ascertain the effects of different periods of bed rest in the subjects. It will be noted that subjects of Groups B and C appear twice in the listings because of the identity of the duration of continuous bed rest when the measurements were made, as provided by the schedule shown in Table 1. It will also be noted that the groupings in Table 3 eliminate, as appropriate, the subjects who were studied early in the experiment, but who dropped out during the course of the experiments. These groupings permitted statistical evaluation by paired t-test of differences seen between the base values and each period of continuous bed rest indicated.

The measurements made by UCB personnel fell into 3 categories:

- (1) *in vivo* body compartment measurements made at the Human Research Facility;
- (2) biochemical analyses for various blood constituent levels made on samples taken to UCB;
- (3) determination of a number of urinary constituent excretion rates from 24-hr urine collections made at the Human Research Facility and analyzed at UCB.

Results from the first 2 classes of measurements have been reported earlier in Semi-Annual Status Report No. 5. The results of the urine analyses are reported herein.

The urine collections were started at approximately 0700 on the morning of the UCB test days shown in Table 1, and continued until approximately 0700 of the next day. Collection times were noted for each subject, and the urine was preserved by the addition of thymol crystals to the collection. On delivery to UCB, the volume, specific gravity, osmolarity, and pH of the collection were measured, and aliquot samples were frozen for subsequent

additional analyses. The samples were analyzed for concentration of chloride, sodium, potassium, magnesium, calcium, phosphate, total nitrogen, ammonia, urea, creatinine, creatine, hydroxyproline, glucose, citrate, 17-hydroxy-corticosteroids, epinephrine, and norepinephrine, and 24-hr excretion rates were computed for each constituent.

All the urine analysis data obtained by our laboratory from the 1974 NASA/Ames Time Course Bed-Rest Study, tabulated according to the group and date arrangements shown in Tables 1 and 2, are listed for each constituent measured in Tables 4 to 26. The same data, appropriately selected and arranged as in Table 3 for paired comparison, are given in Tables 27 to 34. Also shown in the latter tables are the mean, standard deviation, and standard error for each parameter base value before bed rest and value on the day of bed rest indicated. The absolute difference between the base mean and the bed-rest mean, the percentage of the base mean represented by the bed-rest mean, and the probability by paired t-test that the base mean and bed-rest mean are not statistically distinguishable are given for each constituent at the bottom of Tables 27 to 34.

Table 35 summarizes the percentage changes for each urine constituent examined during the course of the 1974 NASA/Ames Time Course Bed-Rest Study. The values shown represent the bed-rest mean values as a percentage of the base mean value for the particular subject group involved, and were taken from Tables 27 to 34. The statistically significant differences are indicated.

Examination of Table 18, however, which gives the 24-hr urine creatinine excretion rates, shows large variability both among the subjects and for the same subject in many cases. For example, the mean base value for all 14 subjects is 17.1 mmol/24 hr with a standard deviation of  $\pm 4.0$  mmol/24 hr.

This yields a coefficient of variation of 23.4%, which is much greater than would be expected normally.

A possible reason for the exceptionally high variance in urinary creatinine excretion rate is inaccuracy in making the 24-hr urine collection. Therefore, the excretion of the other urinary constituents was computed as unit excreted per unit of creatinine measured in each sample. The results are given in Tables 36 to 52 for all the urine samples analyzed, and these data arranged for paired comparison by t-test are repeated in Tables 53 to 60 as before.

Table 61 summarizes the percentage change of each constituent, based on the creatinine concentration of each sample, as a function of days of continuous recumbency, and probably represents a more valid comparison of the subjects than does Table 35. Therefore, comment will be restricted to the data of Table 61.

The striking generalization which emerges on inspection of Table 61 is the lack of discernible effect of the bed-rest conditions of this experiment on urinary constituent excretion rates. With one exception, the only statistically significant variations observed were a small increase in chloride excreted per unit of creatinine excreted, and decreases in phosphate, total nitrogen and urea excretion on Day 2. The change in chloride excretion was probably not of physiological significance, and the change in the other constituent excretion rates is readily attributable to variations in dietary intake. The only other statistically significant difference noted was a small increase in ammonia excretion on Day 19 of bed rest. However, here again the most likely conclusion is that this was not of physiological significance.

There is suggestion in the data that calcium and creatine excretion may have been elevated during bed rest, and that epinephrine and norepinephrine

excretion may have been depressed. However, this impression could not be confirmed statistically, even though such changes might have been expected. In contrast, there was no indication of an expected increase in either phosphate or 17-hydroxycorticosteroid excretion, which also might have been expected.

A possible explanation for the essentially negative findings from the urine analyses of this study may lie in the combination of the high level of variance associated with the sample collections and the small number of subjects involved in the longer bed-rest periods. It is technically difficult, yet essential, to make rigorously quantitative urine collections from human subjects if excretion rates of constituents are to be assessed accurately. The variance in results is further increased substantially unless the dietary intake is carefully standardized. Finally, the use of only 3 or 4 subjects is marginal at best for drawing statistically valid conclusions.

The results of the blood analyses from this study reported previously in Semi-Annual Status Report No. 5 indicate clearly that major metabolic adjustments occur during prolonged bed rest. It would be worthwhile to repeat the measurement of urinary metabolite excretion rates under more carefully controlled experimental conditions.

Table 1. Schedule of tests performed by the investigators from the University of California, Berkeley (UCB) on the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Date	Group A	Group B	Group C	Group D
22 Jul 74	Enter Facility			
23 Jul 74		Enter Facility		
28 Jul 74	UCB Base Values			
30 Jul 74	Begin Bed Rest	UCB Base Values		
31 Jul 74	UCB Day-2 Values	Begin Bed Rest		
1 Aug 74		UCB Day-2 Values		
5 Aug 74		UCB Day-6 Values		
11 Aug 74				Enter Facility
12 Aug 74			Enter Facility	
17 Aug 74				UCB Base Values
19 Aug 74			UCB Base Values	Begin Bed Rest
20 Aug 74			Begin Bed Rest	
25 Aug 74			UCB Day-6 Values	
31 Aug 74			UCB Day-12 Values	UCB Day-13 Values
6 Sep 74				UCB Day-19 Values

PRECEDING PAGE BLANK NOT FILMED



Table 2. Identification and vital statistics for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Name	Age (yr)	Height (cm)	Weight (kg)	Surface Area (m <sup>2</sup> )
<u>Group A</u>					
STE	Kim E. Sterling	30	186	78.0	2.02
BRO	Robert C. Brown	36	185	93.6	2.18
KUB	Art M. Kubersky	33	168	73.3	1.83
<u>Group B</u>					
CUT	Robert E. Cutting	28	184	87.0	2.10
JON	Thomas W. Jones	27	180	74.0	1.93
SHA	Jimmie X. Shaw	26	183	71.1	1.92
JSM	Joe W. Smith	27	190	89.2	2.17
<u>Group C</u>					
REE	Harry Reece	25	179	71.3	1.89
MEI	Maurice E. Meikle	32	182	83.6	2.05
GRI	Mike W. Griffith	26	178	91.7	2.10
<u>Group D</u>					
CAR	Patrick J. Carson	28	183	77.8	2.00
FIE	Marshall G. Fiegenger	34	185	76.4	2.00
GOO	Alan E. Goodwin	28	183	97.6	2.20
BAR	Joey M. Barrios	30	173	90.7	2.04

Table 3. Identification and vital statistics for the subjects, by experiment groups, of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Name	Age (yr)	Height (cm)	Weight (kg)	Surface Area (m <sup>2</sup> )
<u>2-Day Group</u>					
STE	Kim E. Sterling	30	186	78.0	2.02
BRO	Robert C. Brown	36	185	93.6	2.18
KUB	Art M. Kubersky	33	168	73.3	1.83
CUT	Robert E. Cutting	28	184	87.0	2.10
JON	Thomas W. Jones	27	180	74.0	1.93
SHA	Jimmie X. Shaw	26	183	71.1	1.92
JSM	Joe W. Smith	27	190	89.2	2.17
Mean		30	182	80.9	2.02
S.D.		4	7	8.9	0.13
<u>6-Day Group</u>					
CUT	Robert E. Cutting	28	184	87.0	2.10
JON	Thomas W. Jones	27	180	74.0	1.93
SHA	Jimmie X. Shaw	26	183	71.1	1.92
JSM	Joe W. Smith	27	190	89.2	2.17
MEI	Maurice E. Meikle	32	182	83.6	2.05
GRI	Mike W. Griffith	26	178	91.7	2.10
Mean		28	183	82.8	2.05
S.D.		2	4	8.4	0.10
<u>12-13-Day Group</u>					
GRI	Mike W. Griffith	26	178	91.7	2.10
CAR	Patrick J. Carson	28	183	77.8	2.00
FIE	Marshall G. Fiegener	34	185	76.4	2.00
GOO	Alan E. Goodwin	28	183	97.6	2.20
Mean		29	182	85.9	2.08
S.D.		3	3	10.4	0.10
<u>19-Day Group</u>					
CAR	Patrick J. Carson	28	183	77.8	2.00
FIE	Marshall G. Fiegener	34	185	76.4	2.00
GOO	Alan E. Goodwin	28	183	97.6	2.20
Mean		30	184	83.9	2.07
S.D.		3	1	11.9	0.12

Table 4. Urine volume (liters/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<hr/>				
<u>Group A</u>	28 Jul	31 Jul		
STE	1.51	1.15		
BRO	2.17	1.66		
KUB	1.00	1.16		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	1.99	2.14	1.68	
JON	1.09	1.16	1.44	
SHA	1.75	1.31	1.72	
JSM	1.57	1.41	2.32	
<u>Group C</u>	19 Aug		25 Aug	31 Aug
REE	1.64		--	--
MEI	1.05		0.82	--
GRI	1.50		1.05	1.16
<u>Group D</u>	17 Aug		31 Aug	6 Sep
CAR	3.70		2.46	2.99
FIE	4.78		4.71	3.23
GOO	1.40		3.16	1.71
BAR	1.55		--	--
<hr/>				

Table 5. Urine specific gravity (24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	1.017	1.021		
BRO	1.015	1.021		
KUB	1.022	1.020		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	1.012	1.018	1.020	
JON	1.016	1.013	1.016	
SHA	1.015	1.015	1.021	
JSM	1.013	1.013	1.013	
<u>Group C</u>	19 Aug	25 Aug	31 Aug	
REE	1.017	--	--	
MEI	1.025	1.031	--	
GRI	1.021	1.024	1.020	
<u>Group D</u>	17 Aug	31 Aug	6 Sep	
CAR	1.010	1.010	1.009	
FIE	1.007	1.007	1.009	
GOO	1.016	1.009	1.020	
BAR	1.019	--	--	

Table 6. Urine osmotic activity (osmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<hr/>				
<u>Group A</u>	28 Jul	31 Jul		
STE	0.893	0.936		
BRO	1.246	1.229		
KUB	0.761	0.866		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
UTT	0.734	1.469	1.262	
JON	0.679	0.607	0.919	
SHA	0.955	0.754	1.394	
JSM	0.722	1.234	1.126	
<u>Group C</u>	19 Aug	25 Aug	31 Aug	
REE	0.893	--	--	
MEI	0.950	1.068	--	
GRI	1.116	1.022	0.794	
<u>Group D</u>	17 Aug	31 Aug	6 Sep	
CAR	1.495	1.056	0.845	
FIE	1.666	1.567	0.934	
GOO	1.296	1.066	1.181	
BAR	1.157	--	--	
<hr/>				

Table 7. Urine pH (24 hr) for the subjects of the 1974  
NASA/Ames Time Course Bed-Rest Study.

Subject				
<hr/>				
<u>Group A</u>	28 Jul	31 Jul		
STE	6.60	5.89		
BRO	6.23	6.19		
KUB	6.76	5.89		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	6.83	5.91	6.72	
JON	6.70	6.30	6.89	
SHA	6.31	6.87	6.22	
JSM	6.26	7.52	6.82	
<u>Group C</u>	19 Aug		25 Aug	31 Aug
REE	6.33		--	--
MEI	6.45		6.16	--
GRI	6.47		6.88	6.80
<u>Group D</u>	17 Aug		31 Aug	6 Sep
CAR	6.98		7.18	6.65
FIE	7.08		7.05	7.15
GOO	6.53		6.82	6.47
BAR	6.75		--	--
<hr/>				

Table 8. Urine chloride excretion rate (mmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

---

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	147	224		
BRO	196	256		
KUB	154	161		
 <u>Group B</u>	 30 Jul	 1 Aug	 5 Aug	
CUT	182	278	224	
JON	131	138	198	
SHA	168	157	223	
JSM	114	261	228	
 <u>Group C</u>	 19 Aug		 25 Aug	 31 Aug
REE	128		--	--
MEI	188		178	--
GRI	204		129	149
 <u>Group D</u>	 17 Aug		 31 Aug	 6 Sep
CAR	284		141	101
FIE	210		291	93
GOO	265		179	189
BAR	264		--	--

---

Table 9. Urine sodium excretion rate (mmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

<hr/>				
Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	150	191		
BRO	181	247		
KUB	159	157		
 <u>Group B</u>	 30 Jul	 1 Aug	 5 Aug	
CUT	189	272	252	
JON	150	99	203	
SHA	153	153	209	
JSM	99	278	203	
 <u>Group C</u>	 19 Aug		25 Aug	31 Aug
REE	120		--	--
MEI	192		201	--
GRI	211		140	131
 <u>Group D</u>	 17 Aug		31 Aug	6 Sep
CAR	253		143	111
FIE	211		292	122
GOO	250		193	202
BAR	265		--	--
<hr/>				



Table 10. Urine potassium excretion rate (mmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

---

Subject				
<hr/>				
Group A	28 Jul	31 Jul		
STE	82.6	68.4		
BRO	94.3	107.0		
KUB	63.8	61.2		
Group B	30 Jul	1 Aug	5 Aug	
CUT	85.4	102.2	102.5	
JON	39.1	52.8	76.6	
SHA	67.4	62.2	107.8	
JSM	89.0	123.4	137.8	
Group C	19 Aug	25 Aug	31 Aug	
REE	73.9	--	--	
MEI	48.7	51.1	--	
GRI	95.8	104.9	71.5	
Group D	17 Aug	31 Aug	6 Sep	
CAR	121.7	85.0	52.8	
FIE	113.0	139.9	64.3	
GOO	113.0	68.2	73.0	
BAR	79.2	--	--	

---

Table 11. Urine Na/K ratio (24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<hr/>				
Group A	28 Jul	31 Jul		
STE	1.82	2.79		
BRO	1.92	2.31		
KUB	2.49	2.57		
Group B	30 Jul	1 Aug	5 Aug	
CUT	2.21	2.66	2.46	
JON	3.84	1.88	2.65	
SHA	2.27	2.46	1.94	
JSM	1.11	2.25	1.47	
Group C	19 Aug	25 Aug	31 Aug	
REE	1.62	--	--	
MEI	3.94	3.93	--	
GRI	2.20	1.33	1.83	
Group D	17 Aug	31 Aug	6 Sep	
CAR	2.08	1.68	2.10	
FIE	1.87	2.09	1.90	
GOO	2.21	2.83	2.77	
BAR	3.35	--	--	
<hr/>				

Table 12. Urine magnesium excretion rate (mmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
Group A	28 Jul	31 Jul		
STE	6.48	6.21		
BRO	8.56	8.53		
KUB	2.76	5.24		
Group B	30 Jul	1 Aug	5 Aug	
CUT	3.21	8.61	5.07	
JON	3.81	2.97	3.84	
SHA	5.00	1.78	6.40	
JSM	2.87	2.30	4.68	
Group C	19 Aug	25 Aug	31 Aug	
REE	5.65	--	--	
MEI	4.57	4.47	--	
GRI	6.84	2.84	2.65	
Group D	17 Aug	31 Aug	6 Sep	
CAR	4.77	2.60	4.47	
FIE	6.12	4.41	3.47	
GOO	2.86	4.27	6.88	
BAR	3.41	--	--	

Table 13. Urine calcium excretion rate (mmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	6.67	7.27		
BRO	8.69	7.92		
KUB	3.02	2.99		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	3.36	8.97	4.59	
JON	3.40	4.69	4.56	
SHA	4.73	2.32	4.86	
JSM	1.47	3.89	5.89	
<u>Group C</u>	19 Aug		25 Aug	31 Aug
REE	3.27		--	--
MEI	2.76		2.90	--
GRI	4.99		3.26	3.11
<u>Group D</u>	17 Aug		31 Aug	6 Sep
CAR	4.04		3.99	4.34
FIE	4.92		6.29	4.08
GOO	3.96		4.70	6.24
BAR	3.50		--	--

Table 14. Urine phosphate excretion rate (mmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
Group A	28 Jul	31 Jul		
STE	38.1	29.4		
BRO	52.6	48.8		
KUB	26.4	22.1		
Group B	30 Jul	1 Aug	5 Aug	
CUT	43.3	49.1	61.1	
JON	24.3	22.8	36.6	
SHA	35.3	20.3	52.3	
JSM	26.5	25.6	45.8	
Group C	19 Aug		25 Aug	31 Aug
REE	34.6		--	--
MEI	23.5		41.7	--
GRI	47.0		37.7	23.5
Group D	17 Aug		31 Aug	6 Sep
CAR	43.9		33.9	37.4
FIE	53.8		56.4	33.7
GOO	41.8		46.0	48.5
BAR	36.9		--	--

Table 15. Urine total nitrogen excretion rate (g/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

---

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	11.91	10.79		
BRO	19.29	17.98		
KUB	12.32	10.52		
 <u>Group B</u>	 30 Jul	 1 Aug	 5 Aug	
CUT	12.32	19.70	16.87	
JON	8.96	7.73	11.57	
SHA	14.21	9.76	20.35	
JSM	10.18	15.03	12.20	
 <u>Group C</u>	 19 Aug	 25 Aug	 31 Aug	
REE	13.41	--	--	
MEI	13.43	15.85	--	
GRI	17.24	17.08	10.22	
 <u>Group D</u>	 17 Aug		 31 Aug	 6 Sep
CAR	17.29		16.83	14.59
FIE	14.89		19.94	15.02
GOO	15.20		15.57	16.92
BAR	14.59		--	--

---

Table 16. Urine ammonia excretion rate (mmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

---

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	28.8	39.8		
BRO	37.7	26.9		
KUB	21.8	41.0		
 <u>Group B</u>	 30 Jul	 1 Aug	 5 Aug	
CUT	23.3	64.6	36.5	
JON	16.3	15.4	20.2	
SHA	42.2	22.8	55.9	
JSM	27.8	9.1	22.6	
 <u>Group C</u>	 19 Aug		25 Aug	31 Aug
REE	30.5		--	--
MEI	35.3		36.0	--
GRI	30.5		18.2	15.1
 <u>Group D</u>	 17 Aug		31 Aug	6 Sep
CAR	30.2		26.4	33.8
FIE	33.1		44.2	39.6
GOO	46.6		32.6	48.5
BAR	30.5		--	--

---

Table 17. Urine urea excretion rate (mmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<hr/>				
Group A	28 Jul	31 Jul		
STE	341	309		
BRO	554	558		
KUB	369	271		
Group B	30 Jul	1 Aug	5 Aug	
CUT	316	538	450	
JON	220	170	288	
SHA	388	241	630	
JSM	250	343	283	
Group C	19 Aug		25 Aug	31 Aug
REE	402		--	--
MEI	431		522	--
GRI	532		566	315
Group D	17 Aug		31 Aug	6 Sep
CAR	344		476	339
FIE	210		429	354
GOO	391		342	529
BAR	424		--	--
<hr/>				



Table 18. Urine creatinine excretion rate (mmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

<hr/>				
Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	16.8	16.8		
BRO	18.5	18.2		
KUB	14.9	14.8		
 <u>Group B</u>	 30 Jul	 1 Aug	 5 Aug	
CUT.	14.1	23.7	21.6	
JON	10.8	10.5	18.1	
SHA	14.4	10.9	18.8	
JSM	12.6	22.8	18.8	
 <u>Group C</u>	 19 Aug		25 Aug	31 Aug
REE	19.0		--	--
MEI	19.1		22.3	--
GRI	18.0		16.9	11.3
 <u>Group D</u>	 17 Aug		31 Aug	6 Sep
CAR	18.0		18.4	17.5
FIE	17.3		20.0	16.5
GOO	28.0		17.8	21.6
BAR	17.7		--	--
<hr/>				

Table 19. Urine creatine excretion rate (mmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<hr/>				
Group A	28 Jul	31 Jul		
STE	0.98	0.75		
BRO	0.61	0.34		
KUB	0.45	0.59		
Group B	30 Jul	1 Aug	5 Aug	
CUT	0.55	1.88	2.59	
JON	0.38	0.39	0.54	
SHA	0.48	0.04	1.60	
JSM	0.43	0.73	0.83	
Group C	19 Aug	25 Aug	31 Aug	
REE	0.61	--	--	
MEI	0.17	3.04	--	
GRI	0.51	0.82	0.55	
Group D	17 Aug		31 Aug	6 Sep
CAR	0.12		0.19	0.10
FIE	0.18		0.20	0.74
GOO	1.04		0.21	1.36
BAR	0.72		--	--
<hr/>				

Table 20. Urine hydroxyproline excretion rate (mmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Res Study.

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	0.425	0.466		
BRO	0.629	0.796		
KUB	0.186	0.317		
 <u>Group B</u>	 30 Jul	 1 Aug	 5 Aug	
CUT	0.436	0.739	0.426	
JON	0.490	0.342	0.265	
SHA	0.507	0.333	0.521	
JSM	0.390	0.518	0.444	
 <u>Group C</u>	 19 Aug	 25 Aug	 31 Aug	
REE	0.513	--	--	
MEI	0.220	0.335	--	
GRI	0.471	0.556	0.270	
 <u>Group D</u>	 17 Aug		 31 Aug	 6 Sep
CAR	0.300		0.348	0.346
FIE	0.379		0.554	0.431
GOO	0.406		0.353	0.478
BAR	0.254		--	--

Table 21. Urine glucose excretion rate (mmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

---

Subject				
<hr/>				
<u>Group A</u>	28 Jul	31 Jul		
STE	0.527	0.491		
BRO	0.490	0.554		
KUB	0.260	0.244		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	0.466	0.777	0.561	
JON	0.274	0.167	0.370	
SHA	0.694	0.440	0.968	
JSM	0.445	0.607	0.393	
<u>Group C</u>	19 Aug	25 Aug	31 Aug	
REE	0.401	--	--	
MEI	0.544	0.169	--	
GRI	0.546	0.522	0.552	
<u>Group D</u>	17 Aug	31 Aug	6 Sep	
CAR	0.749	0.862	0.482	
FIE	1.081	1.165	1.306	
GOO	0.411	0.731	0.731	
BAR	0.457	--	--	

---

Table 22. Urine citrate excretion rate (mmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

---

Subject				
<hr/>				
<u>Group A</u>	28 Jul	31 Jul		
STE	7.20	6.28		
BRO	3.41	3.66		
KUB	2.16	2.02		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	2.34	2.82	3.14	
JON	2.04	2.07	3.54	
SHA	2.33	1.85	2.98	
JSM	1.65	3.81	5.50	
<u>Group C</u>	19 Aug		25 Aug	31 Aug
REE	0.99		--	--
MEI	2.49		2.68	--
GRI	2.88		2.13	1.38
<u>Group D</u>	17 Aug		31 Aug	6 Sep
CAR	3.90		4.31	4.01
FIE	3.43		3.62	2.85
GOO	2.78		2.62	2.71
BAR	1.59		--	--

---

Table 23. Urine 17-OH corticosteroid excretion rate ( $\mu\text{mol}/24 \text{ hr}$ ) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<hr/>				
Group A	28 Jul	31 Jul		
STE	13.9	15.9		
BRO	23.6	25.9		
KUB	10.4	21.3		
Group B	30 Jul	1 Aug	5 Aug	
CUT	14.9	31.1	30.3	
JON	9.2	15.6	21.9	
SHA	30.1	17.7	22.8	
JSM	19.1	42.9	26.4	
Group C	19 Aug	25 Aug	31 Aug	
REE	12.5	--	--	
MEI	19.9	14.1	--	
GRI	17.0	15.4	8.0	
Group D	17 Aug	31 Aug	6 Sep	
CAR	26.2	28.8	21.6	
FIE	20.7	27.7	16.4	
GOO	28.4	23.1	21.5	
BAR	15.5	--	--	
<hr/>				

Table 24. Urine epinephrine excretion rate (nmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<hr/>				
Group A	28 Jul	31 Jul		
STE	68.2	67.4		
BRO	100.8	50.2		
KUB	36.2	35.0		
Group B	30 Jul	1 Aug	5 Aug	
CUT	100.6	218.6	113.8	
JON	25.9	37.2	0.0	
SHA	56.4	16.1	68.2	
JSM	9.1	20.6	84.2	
Group C	19 Aug	25 Aug	31 Aug	
REE	347.8	--	--	
MEI	153.4	165.4	--	
GRI	70.1	12.5	25.4	
Group D	17 Aug	31 Aug	6 Sep	
CAR	169.4	108.2	144.5	
FIE	262.1	108.7	80.9	
GOO	165.1	91.4	16.1	
BAR	34.8	--	--	
<hr/>				

Table 25. Urine norepinephrine excretion rate (nmol/24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

---

Subject				
<hr/>				
Group A	28 Jul	31 Jul		
STE	681	891		
BRO	865	417		
KUB	440	598		
Group B	30 Jul	1 Aug	5 Aug	
CUT	628	1131	614	
JON	326	269	785	
SHA	549	259	187	
JSM	385	938	265	
Group C	19 Aug		25 Aug	31 Aug
REE	2722		--	--
MEI	640		926	--
GRI	870		575	545
Group D	17 Aug		31 Aug	6 Sep
CAR	1238		657	990
FIE	1072		579	580
GOO	1053		741	1061
BAR	854		--	--

---



Table 26. Urine norepinephrine/epinephrine excretion (24 hr) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	10.0	13.2		
BRO	8.6	8.3		
KUB	12.2	17.1		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	6.2	5.2	5.4	
JON	12.6	7.2	--	
SHA	9.7	16.1	2.7	
JSM	42.3	45.5	3.1	
<u>Group C</u>	19 Aug	25 Aug	31 Aug	
REE	7.8	--	--	
MEI	4.2	5.6	--	
GRI	12.4	46.0	21.5	
<u>Group D</u>	17 Aug	31 Aug	6 Sep	
CAR	7.3	6.1	6.9	
FIE	4.1	5.3	7.2	
GOO	6.4	8.1	6.6	
BAR	24.5	--	--	

Table 27. Comparison of bed-rest Day 2 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Volume, liters/24 hr	Specific Gravity, 24 hr	Osmotic Activity, osmol/24 hr	pH, 24 hr	Chloride, mmol/24 hr	Sodium, mmol/24 hr	Potassium, mmol/24 hr	Na/K Ratio, 24 hr	Magnesium, mmol/24 hr	Calcium, mmol/24 hr	Phosphate, mmol/24 hr
Value 1-2 days before bed rest											
STE	1.51	1.017	0.893	6.60	147	150	82.6	1.82	6.48	6.67	38.1
BRO	2.17	1.015	1.246	6.23	196	181	94.3	1.92	8.56	8.69	52.6
KUB	1.00	1.022	0.761	6.76	154	159	63.8	2.49	2.76	3.02	26.4
CUT	1.99	1.012	0.734	6.83	182	189	85.4	2.21	3.21	3.36	43.3
JON	1.09	1.016	0.679	6.70	131	150	39.1	3.84	3.81	3.40	24.3
SHA	1.75	1.015	0.955	6.31	168	153	67.4	2.27	5.00	4.73	35.3
JSM	<u>1.57</u>	<u>1.013</u>	<u>0.722</u>	<u>6.26</u>	<u>114</u>	<u>99</u>	<u>89.0</u>	<u>1.11</u>	<u>2.87</u>	<u>1.47</u>	<u>26.5</u>
Mean	1.58	1.016	0.856	6.53	156	154	74.5	2.24	4.67	4.48	35.2
S.D.	0.43	0.003	0.199	0.25	29	29	19.2	0.83	2.17	2.46	10.4
S.E.	0.16	0.001	0.075	0.10	11	11	7.2	0.32	0.82	0.93	3.9
Value on Day 2 of bed rest											
STE	1.15	1.021	0.936	5.89	224	191	68.4	2.79	6.21	7.27	29.4
BRO	1.66	1.021	1.229	6.19	256	247	107.0	2.31	8.53	7.92	48.8
KUB	1.16	1.020	0.866	5.89	161	157	61.2	2.57	5.24	2.99	22.1
CUT	2.14	1.018	1.469	5.91	278	272	102.2	2.66	8.61	8.97	49.1
JON	1.16	1.013	0.607	6.30	138	99	52.8	1.88	2.97	4.69	22.8
SHA	1.31	1.015	0.754	6.87	157	153	62.2	2.46	1.78	2.32	20.3
JSM	<u>1.41</u>	<u>1.013</u>	<u>1.234</u>	<u>7.52</u>	<u>261</u>	<u>278</u>	<u>123.4</u>	<u>2.25</u>	<u>2.30</u>	<u>3.89</u>	<u>25.6</u>
Mean	1.43	1.017	1.014	6.37	211	200	82.5	2.42	5.09	5.44	31.2
S.D.	0.36	0.004	0.306	0.62	58	68	27.7	0.30	2.85	2.60	12.5
S.E.	0.14	0.001	0.116	0.23	22	26	10.5	0.11	1.08	0.98	4.7
$\bar{X}_2 - \bar{X}_1$	-0.15	+0.001	+0.158	-0.16	+ 55	+ 46	+ 8.0	+0.18	+0.42	+0.96	- 4.0
%	90.5	106.3	118.5	97.5	135.3	129.9	110.7	107.8	109.0	121.4	88.6
P	0.20	0.31	0.26	0.62	0.045*	0.16	0.25	0.66	0.70	0.36	0.15

Table 28. Comparison of bed-rest Day 2 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Total Nitrogen, g/24 hr	Ammonia, mmol/24 hr	Urea, mmol/24 hr	Creatinine, mmol/24 hr	Creatine, mmol/24 hr	Hydroxyproline, mmol/24 hr	Glucose, mmol/24 hr	Citrate, mmol/24 hr	17-OHCS, μmol/24 hr	Epinephrine, mmol/24 hr	Norepinephrine, mmol/24 hr	NE/E Ratio, 24 hr
Value 1-2 days before bed rest												
STE	11.91	28.8	341	16.8	0.98	0.425	0.527	7.20	13.9	68.2	681	10.0
BRO	19.29	37.7	554	18.5	0.61	0.629	0.490	3.41	23.6	100.8	865	8.6
KUB	12.32	21.8	369	14.9	0.45	0.186	0.260	2.16	10.4	36.2	440	12.2
CUT	12.32	23.3	316	14.1	0.55	0.436	0.466	2.34	14.9	100.6	628	6.2
JON	8.96	16.3	220	10.8	0.38	0.490	0.274	2.04	9.2	25.9	326	12.6
SHA	14.21	42.2	388	14.4	0.48	0.507	0.694	2.33	30.1	56.4	549	9.7
JSM	10.18	27.8	250	12.6	0.43	0.390	0.445	1.65	19.1	9.1	385	42.3
Mean	12.74	28.3	348	14.6	0.55	0.438	0.451	3.02	17.3	56.7	553	14.5
S.D.	3.34	9.1	109	2.5	0.20	0.135	0.150	1.92	7.5	35.7	188	12.4
S.E.	1.27	3.4	41	1.0	0.08	0.051	0.057	0.73	2.8	13.5	71	4.7
Value on Day 2 of bed rest												
STE	10.79	39.8	309	16.8	0.75	0.466	0.491	6.28	15.9	67.4	891	13.2
BRO	17.98	26.9	558	18.2	0.34	0.796	0.554	3.66	25.9	50.2	417	8.3
KUB	10.52	41.0	271	14.8	0.59	0.317	0.244	2.02	21.3	35.0	598	17.1
CUT	19.70	64.6	538	23.7	1.88	0.739	0.777	2.82	31.1	218.6	1131	5.2
JON	7.73	15.4	170	10.5	0.39	0.342	0.167	2.07	15.6	37.2	269	7.2
SHA	9.76	22.8	241	10.9	0.04	0.333	0.440	1.85	17.7	16.1	259	16.1
JSM	15.03	9.1	343	22.8	0.73	0.518	0.607	3.81	42.9	20.6	938	45.5
Mean	13.07	31.4	347	16.8	0.67	0.502	0.469	3.22	24.3	63.6	643	16.1
S.D.	4.53	18.8	148	5.2	0.59	0.197	0.210	1.57	9.9	70.5	348	13.7
S.E.	1.71	7.1	56	2.0	0.22	0.074	0.079	0.59	3.8	26.7	132	5.2
$\bar{X}_2 - \bar{X}_1$	+0.33	+3.1	-1	+2.2	+0.12	+0.064	+0.018	+0.20	+7.0	+6.9	+90	+1.6
%	102.6	111.0	99.7	115.1	121.8	114.6	104.0	106.6	140.5	112.2	116.3	111.0
P	0.84	0.73	0.98	0.32	0.61	0.36	0.81	0.61	0.16	0.75	0.55	0.34

Table 29. Comparison of bed-rest Day 6 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Volume, liters/24 hr	Specific Gravity, 24 hr	Osmotic Activity, osmol/24 hr	pH, 24 hr	Chloride, mmol/24 hr	Sodium, mmol/24 hr	Potassium, mmol/24 hr	Na/K Ratio, 24 hr	Magnesium, mmol/24 hr	Calcium, mmol/24 hr	Phosphate, mmol/24 hr
<u>Value 1 day before bed rest</u>											
CUT	1.99	1.012	0.734	6.83	182	189	85.4	2.21	3.21	3.36	43.3
JON	1.09	1.016	0.679	6.70	131	150	39.1	3.84	3.81	3.40	24.3
SHA	1.75	1.015	0.955	6.31	168	153	67.4	2.27	5.00	4.73	35.3
JSM	1.57	1.013	0.722	6.26	114	99	89.0	1.11	2.87	1.47	26.5
MEI	1.05	1.025	0.950	6.45	188	192	48.7	3.94	4.57	2.76	23.5
GRI	<u>1.50</u>	<u>1.021</u>	<u>1.116</u>	<u>6.47</u>	<u>204</u>	<u>211</u>	<u>95.8</u>	<u>2.20</u>	<u>6.84</u>	<u>4.99</u>	<u>47.0</u>
Mean	1.49	1.017	0.859	6.50	165	166	70.9	2.60	4.38	3.45	33.3
S.D.	0.37	0.005	0.173	0.22	35	40	23.1	1.09	1.45	1.30	10.1
S.E.	0.15	0.002	0.071	0.09	14	16	9.4	0.45	0.59	0.53	4.1
<u>Value on Day 6 of bed rest</u>											
CUT	1.68	1.020	1.262	6.72	224	252	102.5	2.46	5.07	4.59	61.1
JON	1.44	1.016	0.919	6.89	198	203	76.6	2.65	3.84	4.56	36.6
SHA	1.72	1.021	1.394	6.22	223	209	107.8	1.94	6.40	4.86	52.3
JSM	2.32	1.013	1.126	6.82	228	203	137.8	1.47	4.68	5.89	45.8
MEI	0.82	1.031	1.068	6.16	178	201	51.1	3.93	4.47	2.90	41.7
GRI	<u>1.05</u>	<u>1.024</u>	<u>1.022</u>	<u>6.88</u>	<u>129</u>	<u>140</u>	<u>104.9</u>	<u>1.33</u>	<u>2.84</u>	<u>3.26</u>	<u>37.7</u>
Mean	1.51	1.021	1.132	6.62	197	201	96.8	2.30	4.55	4.34	45.9
S.D.	0.53	0.006	0.172	0.34	38	36	29.7	0.96	1.20	1.10	9.4
S.E.	0.22	0.003	0.070	0.14	16	15	12.1	0.39	0.49	0.45	3.8
$\bar{X}_2 - \bar{X}_1$	+0.02	+0.004	+0.273	+0.12	+ 32	+ 35	+25.9	-0.30	+0.17	+0.89	+12.6
%	101.3	123.5	131.8	101.8	119.4	121.1	136.5	88.5	103.9	125.8	137.8
P	0.95	0.039*	0.035*	0.45	0.29	0.21	0.020*	0.29	0.86	0.33	0.038*

Table 30. Comparison of bed-rest Day 6 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Total Nitrogen, g/24 hr	Ammonia, mmol/24 hr	Urea, mmol/24 hr	Creatinine, mmol/24 hr	Creatine, mmol/24 hr	Hydroxyproline, mmol/24 hr	Glucose, mmol/24 hr	Citrate, mmol/24 hr	17-OHCS, μmol/24 hr	Epinephrine, nmol/24 hr	Norepinephrine, nmol/24 hr	NE/E Ratio, 24 hr
Value 1 day before bed rest												
CUT	12.32	23.3	316	14.1	0.55	0.436	0.466	2.34	14.9	100.6	628	6.2
JON	8.96	16.3	220	10.8	0.38	0.490	0.274	2.04	9.2	25.9	326	12.6
SHA	14.21	42.2	388	14.4	0.48	0.507	0.694	2.33	30.1	56.4	549	9.7
JSM	10.18	27.8	250	12.6	0.43	0.390	0.445	1.65	19.1	9.1	385	42.3
MEI	13.43	35.3	431	19.1	0.17	0.220	0.544	2.49	19.9	153.4	640	4.2
GRI	17.24	30.5	532	18.0	0.51	0.471	0.546	2.88	17.0	70.1	870	12.4
Mean	12.72	29.2	356	14.8	0.42	0.419	0.495	2.29	18.4	69.3	566	14.6
S.D.	2.96	9.1	117	3.2	0.14	0.106	0.139	0.42	6.9	52.4	196	14.0
S.E.	1.21	3.7	48	1.3	0.06	0.043	0.057	0.17	2.8	21.4	80	5.7
Value on Day 6 of bed rest												
CUT	16.87	36.5	450	21.6	2.59	0.426	0.561	3.14	30.3	113.8	614	5.4
JON	11.57	20.2	288	18.1	0.54	0.265	0.370	3.54	21.9	0.0	785	--
SHA	20.35	55.9	630	18.8	1.60	0.521	0.968	2.98	22.8	68.2	187	2.7
JSM	12.20	22.6	283	18.8	0.83	0.444	0.393	5.50	26.4	84.2	265	3.1
MEI	15.85	36.0	522	22.3	3.04	0.335	0.169	2.68	14.1	165.4	926	5.6
GRI	17.08	18.2	566	16.9	0.82	0.556	0.522	2.13	15.4	12.5	575	46.0
Mean	15.65	31.6	457	19.4	1.57	0.425	0.497	3.33	21.8	74.0	559	12.6
S.D.	3.29	14.3	145	2.1	1.04	0.110	0.269	1.16	6.2	62.2	288	18.7
S.E.	1.34	5.8	59	0.9	0.42	0.045	0.110	0.48	2.5	25.4	117	8.4
$\bar{X}_2 - \bar{X}_1$	+2.93	+2.4	+101	+4.6	+1.15	+0.006	+0.002	+1.04	+3.4	+4.7	-7	-2.0
%	123.0	108.2	128.4	131.1	373.8	101.4	100.4	145.4	118.5	106.8	98.8	86.3
P	0.022*	0.60	0.027*	0.018*	0.050*	0.92	0.98	0.16	0.41	0.80	0.96	0.85

Table 31. Comparison of bed rest Day 12-13 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Volume, liters/24 hr	Specific Gravity, 24 hr	Osmotic Activity, osmol/24 hr	pH, 24 hr	Chloride, mmol/24 hr	Sodium, mmol/24 hr	Potassium, mmol/24 hr	Na/K Ratio, 24 hr	Magnesium, mmol/24 hr	Calcium, mmol/24 hr	Phosphate, mmol/24 hr
Value 1-2 days before bed rest											
GRI	1.50	1.021	1.116	6.47	204	211	95.8	2.20	6.84	4.99	47.0
CAR	3.70	1.010	1.495	6.98	284	253	121.7	2.08	4.77	4.04	43.9
FIE	4.78	1.007	1.666	7.08	210	211	113.0	1.87	6.12	4.92	53.8
GOO	1.40	1.016	1.296	6.53	265	250	113.0	2.21	2.86	3.96	41.8
Mean	2.85	1.014	1.393	6.77	241	231	110.9	2.09	5.15	4.48	46.6
S.D.	1.67	0.006	0.239	0.31	40	23	10.9	0.16	1.75	0.55	5.2
S.E.	0.84	0.003	0.119	0.15	20	12	5.4	0.08	0.87	0.28	2.6
Value on Day 12-13 of bed rest											
GRI	1.16	1.020	0.794	6.80	149	131	71.5	1.83	2.65	3.11	23.5
CAR	2.46	1.010	1.056	7.18	141	143	85.0	1.68	2.60	3.99	33.9
FIE	4.71	1.007	1.567	7.05	291	292	139.9	2.09	4.41	6.29	56.4
GOO	3.16	1.009	1.066	6.82	179	193	68.2	2.83	4.27	4.70	46.0
Mean	2.87	1.012	1.121	6.96	190	190	91.2	2.11	3.48	4.52	40.0
S.D.	1.48	0.006	0.323	0.18	69	73	33.3	0.51	0.99	1.35	14.3
S.E.	0.74	0.003	0.161	0.09	35	37	16.7	0.26	0.50	0.67	7.2
$\bar{X}_2 - \bar{X}_1$	+0.02	-0.002	-0.272	+0.19	-51	-41	-19.7	+0.02	-1.67	+0.04	-6.6
%	100.7	85.7	80.5	102.8	78.8	82.3	82.2	101.0	67.6	100.9	85.8
P	0.97	0.32	0.032*	0.092	0.36	0.40	0.31	0.95	0.25	0.95	0.38

Table 32. Comparison of bed rest Day 12-13 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Total Nitrogen, g/24 hr	Ammonia, mmol/24 hr	Urea, mmol/24 hr	Creatinine, mmol/24 hr	Creatine, mmol/24 hr	Hydroxyproline, mmol/24 hr	Glucose, mmol/24 hr	Citrate, mmol/24 hr	17-OHCS μmol/24 hr	Epinephrine, nmol/24 hr	Norepinephrine, nmol/24 hr	NE/E Ratio, 24 hr
Value 1-2 days before bed rest												
GRI	17.24	30.5	532	18.0	0.51	0.471	0.546	2.88	17.0	70.1	870	12.4
CAR	17.29	30.2	344	18.0	0.12	0.300	0.749	3.90	26.2	169.4	1238	7.3
FIE	14.89	33.1	210	17.3	0.18	0.379	1.081	3.43	20.7	262.1	1072	4.1
GOO	<u>15.20</u>	<u>46.6</u>	<u>391</u>	<u>28.0</u>	<u>1.04</u>	<u>0.406</u>	<u>0.411</u>	<u>2.78</u>	<u>28.4</u>	<u>165.1</u>	<u>1053</u>	<u>6.4</u>
Mean	16.16	35.1	369	20.3	0.46	0.389	0.697	3.25	23.1	166.7	1058	7.6
S.D.	1.29	7.8	133	5.1	0.42	0.071	0.291	0.52	5.2	78.4	151	3.5
S.E.	0.64	3.9	66	2.6	0.21	0.035	0.146	0.26	2.6	39.2	75	1.8
Value on Day 12-13 of bed rest												
GRI	10.22	15.1	315	11.3	0.55	0.270	0.552	1.38	8.0	25.4	545	21.5
CAR	16.83	26.4	476	18.4	0.19	0.348	0.862	4.31	28.8	108.2	657	6.1
FIE	19.94	44.2	429	20.0	0.20	0.554	1.165	3.62	27.7	108.7	579	5.3
GOO	<u>15.57</u>	<u>32.6</u>	<u>342</u>	<u>17.8</u>	<u>0.21</u>	<u>0.353</u>	<u>0.731</u>	<u>2.62</u>	<u>23.1</u>	<u>91.4</u>	<u>741</u>	<u>8.1</u>
Mean	15.64	29.6	391	16.9	0.29	0.381	0.828	2.98	21.9	83.4	631	10.3
S.D.	4.05	12.1	75	3.8	0.18	0.121	0.258	1.27	9.6	39.5	87	7.6
S.E.	2.03	6.1	37	1.9	0.09	0.060	0.129	0.64	4.8	19.8	44	3.8
$\bar{X}_2 - \bar{X}_1$	-0.52	-5.5	+22	-3.4	-0.17	-0.008	+0.131	-0.27	-1.2	-83.3	-427	+2.7
%	96.8	84.3	106.0	83.3	63.0	97.9	118.8	91.7	94.8	50.0	59.6	135.5
P	0.85	0.43	0.84	0.33	0.48	0.93	0.15	0.58	0.77	0.041*	0.007*	0.31

Table 33. Comparison of bed rest Day 19 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Volume, liters/24 hr	Specific Gravity, 24 hr	Osmotic Activity, osmol/24 hr	pH, 24 hr	Chloride, mmol/24 hr	Sodium, mmol/24 hr	Potassium, mmol/24 hr	Na/K Ratio, 24 hr	Magnesium, mmol/24 hr	Calcium, mmol/24 hr	Phosphate, mmol/24 hr
Value 2 days before bed rest											
CAR	3.70	1.010	1.495	6.98	284	253	121.7	2.08	4.77	4.04	43.9
FIE	4.78	1.007	1.666	7.08	210	211	113.0	1.87	6.12	4.92	53.8
GOO	<u>1.40</u>	<u>1.016</u>	<u>1.296</u>	<u>6.53</u>	<u>265</u>	<u>250</u>	<u>113.0</u>	<u>2.21</u>	<u>2.86</u>	<u>3.96</u>	<u>41.8</u>
Mean	3.29	1.011	1.486	6.86	253	238	115.9	2.05	4.58	4.31	46.5
S.D.	1.73	0.005	0.185	0.29	38	23	5.0	0.17	1.64	0.53	6.4
S.E.	1.00	0.003	0.107	0.17	22	14	2.9	0.10	0.95	0.31	3.7
Value on Day 19 of bed rest											
CAR	2.99	1.009	0.845	6.65	101	111	52.8	2.10	4.47	4.34	37.4
FIE	3.23	1.009	0.934	7.15	93	122	64.3	1.90	3.47	4.08	33.7
GOO	<u>1.71</u>	<u>1.020</u>	<u>1.181</u>	<u>6.47</u>	<u>189</u>	<u>202</u>	<u>73.0</u>	<u>2.77</u>	<u>6.88</u>	<u>6.24</u>	<u>48.5</u>
Mean	2.64	1.013	0.987	6.76	128	145	63.4	2.26	4.94	4.89	39.9
S.D.	0.82	0.006	0.174	0.35	53	50	10.1	0.46	1.75	1.18	7.7
S.E.	0.47	0.004	0.100	0.20	31	29	5.8	0.26	1.01	0.68	4.4
$\bar{X}_2 - \bar{X}_1$	-0.65	+0.002	-0.499	-0.10	-125	-93	-52.5	+0.21	+0.36	+0.58	-6.6
%	80.2	118.2	66.4	98.5	50.6	60.9	54.7	110.2	107.9	113.5	85.8
P	0.35	0.37	0.12	0.46	0.057	0.076	0.026*	0.37	0.87	0.59	0.48



Table 34. Comparison of bed rest Day 19 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Total Nitrogen, g/24 hr	Ammonia, mmol/24 hr	Urea, mmol/24 hr	Creatinine, mmol/24 hr	Creatine, mmol/24 hr	Hydroxyproline, mmol/24 hr	Glucose, mmol/24 hr	Citrate, mmol/24 hr	17-OHCS, μmol/24 hr	Epinephrine, nmol/24 hr	Norepinephrine, nmol/24 hr	NE/E Ratio, 24 hr
<u>Value 2 days before bed rest</u>												
CAR	17.29	30.2	344	18.0	0.12	0.300	0.749	3.90	26.2	169.4	1238	7.3
FIE	14.89	33.1	210	17.3	0.18	0.379	1.081	3.43	20.7	262.1	1072	4.1
GOO	<u>15.20</u>	<u>46.6</u>	<u>391</u>	<u>28.0</u>	<u>1.04</u>	<u>0.406</u>	<u>0.411</u>	<u>2.78</u>	<u>28.4</u>	<u>165.1</u>	<u>1053</u>	<u>6.4</u>
Mean	15.79	36.6	315	21.1	0.45	0.362	0.747	3.37	25.1	198.9	1121	5.9
S.D.	1.31	8.8	94	6.0	0.51	0.055	0.335	0.56	4.0	54.8	102	1.7
S.E.	0.75	5.1	54	3.5	0.30	0.032	0.193	0.32	2.3	31.6	59	1.0
<u>Value on Day 19 of bed rest</u>												
CAR	14.59	33.8	339	17.5	0.10	0.346	0.482	4.01	21.6	144.5	990	6.9
FIE	15.02	39.6	354	16.5	0.74	0.431	1.306	2.85	16.4	80.9	580	7.2
GOO	<u>16.92</u>	<u>48.5</u>	<u>529</u>	<u>21.6</u>	<u>1.36</u>	<u>0.478</u>	<u>0.731</u>	<u>2.71</u>	<u>21.5</u>	<u>16.1</u>	<u>1061</u>	<u>6.6</u>
Mean	15.51	40.6	407	18.5	0.73	0.418	0.840	3.19	19.8	80.5	877	6.9
S.D.	1.24	7.4	106	2.7	0.63	0.067	0.423	0.71	3.0	64.2	260	0.3
S.E.	0.72	4.3	61	1.6	0.36	0.039	0.244	0.41	1.7	37.1	150	0.2
$\bar{X}_2 - \bar{X}_1$	-0.28	+4.0	+92	-2.6	+0.28	+0.056	+0.093	-0.18	-5.3	-118.4	-244	+1.0
%	98.2	110.9	192.2	87.7	162.2	115.5	112.4	94.7	78.9	40.5	78.2	116.9
P	0.85	0.097	0.20	0.31	0.23	0.018*	0.66	0.48	0.023*	0.13	0.23	0.47

Table 35. Summary of percentage changes in urine constituents from the base mean value on various days during the course of continuous recumbency. The percentages statistically significantly different from the base value of 100% ( $P < 0.05$ ) are indicated by an asterisk.

Constituent	Day 2	Day 6	Day 12-13	Day 19
Urine Volume	90.5	101.3	100.7	80.2
Specific Gravity	106.3	123.5*	85.7	118.2
Osmotic Activity	118.5	131.8*	80.5*	66.4
pH	97.5	101.8	102.8	98.5
Chloride	135.3*	119.4	78.8	50.6
Sodium	129.9	121.1	82.3	60.9
Potassium	110.7	136.5*	82.2	54.7*
Na/K Ratio	107.8	88.5	101.0	110.2
Magnesium	109.0	103.9	67.6	107.9
Calcium	121.4	125.8	100.9	113.5
Phosphate	88.6	137.8*	85.8	85.8
Total Nitrogen	102.6	123.0*	96.8	98.2
Ammonia	111.0	108.2	84.3	110.9
Urea	99.7	128.4*	106.0	129.2
Creatinine	115.1	131.1*	83.3	87.7
Creatine	121.8	373.8*	63.0	162.2
Hydroxyproline	114.6	101.4	97.9	115.5*
Glucose	104.0	100.4	118.8	112.4
Citrate	106.6	145.4	91.7	94.7
17-OH Corticosteroids	140.5	118.5	94.8	78.9*
Epinephrine	112.2	106.8	50.0*	40.5
Norepinephrine	116.3	98.8	59.6*	78.2
NE/E Ratio	111.0	86.3	135.5	116.9

Table 36. Urine osmotic activity (mosmol/mol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<hr/>				
Group A	28 Jul	31 Jul		
STE	53.2	55.7		
BRO	67.4	67.5		
KUB	51.1	58.5		
Group B	30 Jul	1 Aug	5 Aug	
CUT	52.1	62.0	58.4	
JON	62.9	57.8	50.8	
SHA	66.3	69.2	74.1	
JSM	57.3	54.1	59.9	
Group C	19 Aug	25 Aug	31 Aug	
REE	47.0	--	--	
MEI	49.7	47.9	--	
GRI	62.0	60.5	70.3	
Group D	17 Aug	31 Aug	6 Sep	
CAR	83.0	57.4	48.3	
FIE	96.3	78.4	56.6	
GOO	46.3	59.9	54.7	
BAR	65.4		--	
<hr/>				

Table 37. Urine chloride excretion (mol/mol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	8.8	13.3		
BRO	10.6	14.1		
KUB	10.3	10.9		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	12.9	11.7	10.4	
JON	12.1	13.1	10.9	
SHA	11.7	14.4	11.9	
JSM	9.0	11.4	12.1	
<u>Group C</u>	19 Aug		25 Aug	31 Aug
REE	6.7		--	--
MEI	9.8		8.0	--
GRI	11.3		7.6	13.2
<u>Group D</u>	17 Aug		31 Aug	6 Sep
CAR	15.8		7.7	5.8
FIE	12.1		14.6	5.6
GOO	9.5		10.1	8.8
BAR	14.9		--	--

Table 38. Urine sodium excretion (mol/mol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	8.9	11.4		
BRO	9.8	13.6		
KUB	10.7	10.6		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	13.1	11.5	11.7	
JON	13.9	9.4	11.2	
SHA	10.6	14.0	11.1	
JSM	7.9	12.2	10.8	
<u>Group C</u>	19 Aug	25 Aug	31 Aug	
REE	6.3	--	--	
MEI	10.1	9.0	--	
GRI	11.7	8.3	11.6	
<u>Group D</u>	17 Aug		31 Aug	6 Sep
CAR	14.1		7.8	6.3
FIE	12.2		14.6	7.4
GOO	8.9		10.8	9.4
BAR	15.0		--	--

Table 39. Urine potassium excretion (mol/mol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<hr/>				
Group A	28 Jul	31 Jul		
STE	4.92	4.07		
BRO	5.10	5.88		
KUB	4.28	4.14		
Group B	30 Jul	1 Aug	5 Aug	
CUT	6.06	4.31	4.75	
JON	3.62	5.03	4.23	
SHA	4.68	5.71	5.73	
JSM	7.06	5.41	7.33	
Group C	19 Aug	25 Aug	31 Aug	
REE	3.89	--	--	
MEI	2.55	2.29	--	
GRI	5.32	6.21	6.33	
Group D	17 Aug	31 Aug	6 Sep	
CAR	6.76	4.62	3.02	
FIE	6.53	7.00	3.90	
GOO	4.04	3.83	3.38	
BAR	4.47	--	--	
<hr/>				

Table 40. Urine magnesium excretion (mmol/mol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

---

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	386	370		
BRO	463	469		
KUB	185	354		
 <u>Group B</u>	 30 Jul	 1 Aug	 5 Aug	
CUT	228	363	235	
JON	353	283	212	
SHA	347	163	340	
JSM	228	101	249	
 <u>Group C</u>	 19 Aug		25 Aug	31 Aug
REE	297		--	--
MEI	239		200	--
GRI	380		168	235
 <u>Group D</u>	 17 Aug		31 Aug	6 Sep
CAR	265		141	255
FIE	354		221	210
GOO	102		240	319
BAR	193		--	--

Table 41. Urine calcium excretion (mmol/mol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

---

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	397	433		
BRO	470	435		
KUB	203	202		
 <u>Group B</u>	 30 Jul	 1 Aug	 5 Aug	
CUT	238	378	213	
JON	315	447	252	
SHA	328	213	259	
JSM	117	171	313	
 <u>Group C</u>	 19 Aug	 25 Aug	 31 Aug	
REE	172	--	--	
MEI	145	130	--	
GRI	277	193	275	
 <u>Group D</u>	 17 Aug		 31 Aug	 6 Sep
CAR	224		217	248
FIE	284		315	247
GOO	141		264	289
BAR	198		--	--

---



Table 42. Urine phosphate excretion (mol/mol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

<hr/>				
Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	2.27	1.75		
BRO	2.84	2.68		
KUB	1.77	1.49		
 <u>Group B</u>	 30 Jul	 1 Aug	 5 Aug	
CUT	3.07	2.07	2.83	
JON	2.25	2.17	2.02	
SHA	2.45	1.86	2.78	
JSM	2.10	1.12	2.44	
 <u>Group C</u>	 19 Aug		25 Aug	31 Aug
REE	1.82		--	--
MEI	1.23		1.87	--
GRI	2.61		2.23	2.08
 <u>Group D</u>	 17 Aug		31 Aug	6 Sep
CAR	2.44		1.84	2.14
FIE	3.11		2.82	2.04
GOO	1.49		2.58	2.25
BAR	2.08		--	--
<hr/>				

Table 43. Urine total nitrogen excretion (g/mmol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	0.71	0.64		
BRO	1.04	0.99		
KUB	0.83	0.71		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	0.87	0.83	0.78	
JON	0.83	0.74	0.64	
SHA	0.99	0.90	1.08	
JSM	0.81	0.66	0.65	
<u>Group C</u>	19 Aug	25 Aug	31 Aug	
REE	0.71	--	--	
MEI	0.70	0.71	--	
GRI	0.96	1.01	0.90	
<u>Group D</u>	17 Aug	31 Aug	6 Sep	
CAR	0.96	0.91	0.83	
FIE	0.86	1.00	0.91	
GOO	0.54	0.87	0.78	
BAR	0.83	--	--	

Table 44. Urine ammonia excretion (mol/mol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
Group A	28 Jul	31 Jul		
STE	1.71	2.37		
BRO	2.04	1.48		
KUB	1.46	2.77		
Group B	30 Jul	1 Aug	5 Aug	
CUT	1.65	2.73	1.69	
JON	1.51	1.47	1.12	
SHA	2.93	2.09	2.97	
JSM	2.21	0.40	1.20	
Group C	19 Aug	25 Aug	31 Aug	
REE	1.61	--	--	
MEI	1.85	1.61	--	
GRI	1.69	1.08	1.34	
Group D	17 Aug	31 Aug	6 Sep	
CAR	1.68	1.43	1.93	
FIE	1.91	2.21	2.40	
GOO	1.66	1.83	2.25	
BAR	1.72	--	--	

Table 45. Urine urea excretion (mol/mol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	20.3	18.4		
BRO	29.9	30.7		
KUB	24.8	18.3		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	22.4	22.7	20.8	
JON	20.4	16.2	15.9	
SHA	26.9	22.1	33.5	
JSM	19.8	15.0	15.1	
<u>Group C</u>	19 Aug		25 Aug	31 Aug
REE	21.2		--	--
MEI	22.6		23.4	--
GRI	29.6		33.5	27.9
<u>Group D</u>	17 Aug		31 Aug	6 Sep
CAR	19.1		25.9	19.4
FIE	12.1		21.5	21.5
GOO	14.0		19.2	24.5
BAR	24.0		--	--

Table 46. Urine creatine excretion (mmol/mol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

---

Subject				
<hr/>				
<u>Group A</u>	28 Jul	31 Jul		
STE	58.3	44.6		
BRO	33.0	18.7		
KUB	30.2	39.9		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	39.0	79.3	119.9	
JON	35.2	37.1	29.8	
SHA	33.3	3.7	85.1	
JSM	34.1	32.0	44.1	
<u>Group C</u>	19 Aug		25 Aug	31 Aug
REE	32.1		--	--
MEI	8.9		179.9	--
GRI	28.3		48.5	48.7
<u>Group D</u>	17 Aug		31 Aug	6 Sep
CAR	6.7		10.3	5.7
FIE	10.4		10.0	44.8
GOO	37.1		11.8	63.0
BAR	40.7		--	--

---

Table 47. Urine hydroxyproline excretion (mmol/mol creatinine)  
for the subjects of the 1974 NASA/Ames Time Course  
Bed-Rest Study.

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	25.3	27.7		
BRO	34.0	43.7		
KUB	12.5	21.4		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	30.9	31.2	19.7	
JON	45.4	32.6	14.6	
SHA	35.2	30.6	27.7	
JSM	31.0	22.7	23.6	
<u>Group C</u>	19 Aug		25 Aug	31 Aug
REE	27.0		--	--
MEI	11.5		15.0	--
GRI	26.2		32.9	23.9
<u>Group D</u>	17 Aug		31 Aug	6 Sep
CAR	16.7		18.9	19.8
FIE	21.9		27.7	26.1
GOO	14.5		19.8	22.1
BAR	14.4		--	--

Table 48. Urine glucose excretion (mmol/mol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<hr/>				
Group A	28 Jul	31 Jul		
STE	31.4	29.2		
BRO	26.5	30.4		
KUB	17.4	16.5		
Group B	30 Jul	1 Aug	5 Aug	
CUT	33.0	32.8	26.0	
JON	25.4	15.9	20.4	
SHA	48.2	40.4	51.5	
JSM	35.3	26.6	20.9	
Group C	19 Aug		25 Aug	31 Aug
REE	21.1		--	--
MEI	28.5		7.6	--
GRI	30.3		30.9	48.8
Group D	17 Aug		19 Aug	6 Sep
CAR	41.6		46.8	27.5
FIE	62.5		58.3	79.2
GOO	14.7		41.1	33.8
BAR	25.8		--	--
<hr/>				

Table 49. Urine citrate excretion (mmol/mol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

---

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	429	374		
BRO	184	201		
KUB	145	136		
 <u>Group B</u>	 30 Jul	 1 Aug	 5 Aug	
CUT	166	119	145	
JON	189	197	196	
SHA	162	170	159	
JSM	131	167	293	
 <u>Group C</u>	 19 Aug		25 Aug	31 Aug
REE	52		--	--
MEI	130		120	--
GRI	160		126	122
 <u>Group D</u>	 17 Aug		31 Aug	6 Sep
CAR	217		234	229
FIE	198		181	173
GOO	99		147	125
BAR	90		--	--

---



Table 50. Urine 17-OH corticosteroid excretion (nmol/mol creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

---

Subject				
<hr/>				
<u>Group A</u>	28 Jul	31 Jul		
STE	0.83	0.95		
BRO	1.28	1.42		
KUB	0.70	1.44		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	1.06	1.31	1.40	
JON	0.85	1.49	1.21	
SHA	2.09	1.62	1.21	
JSM	1.52	1.88	1.40	
<u>Group C</u>	19 Aug	25 Aug	31 Aug	
REE	0.66	--	--	
MEI	1.04	0.63	--	
GRI	0.94	0.91	0.71	
<u>Group D</u>	17 Aug	31 Aug	6 Sep	
CAR	1.46	1.57	1.23	
FIE	1.20	1.39	0.99	
GOO	1.01	1.30	1.00	
BAR	0.88	--	--	

---

Table 51. Urine epinephrine excretion ( $\mu\text{mol/mol}$  creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<hr/>				
<u>Group A</u>	28 Jul	31 Jul		
STE	4.06	4.01		
BRO	5.45	2.76		
KUB	2.43	2.36		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	7.13	9.22	5.27	
JON	2.40	3.54	0.00	
SHA	3.92	1.48	3.63	
JSM	0.72	0.90	4.48	
<u>Group C</u>	19 Aug		25 Aug	31 Aug
REE	18.31		--	--
MEI	8.03		7.42	--
GRI	3.89		0.74	2.25
<u>Group D</u>	17 Aug		31 Aug	6 Sep
CAR	9.41		6.18	8.26
FIE	15.15		6.59	4.90
GOO	5.90		4.23	0.75
BAR	1.97		--	--
<hr/>				

Table 52. Urine norepinephrine excretion ( $\mu\text{mol/mol}$  creatinine) for the subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject				
<u>Group A</u>	28 Jul	31 Jul		
STE	40.5	53.0		
BRO	46.8	22.9		
KUB	29.5	40.4		
<u>Group B</u>	30 Jul	1 Aug	5 Aug	
CUT	44.5	47.7	28.4	
JON	30.2	25.6	43.4	
SHA	38.1	23.8	9.9	
JSM	30.6	41.1	14.1	
<u>Group C</u>	19 Aug	25 Aug	31 Aug	
REE	143.3	--	--	
MEI	33.5	41.5	--	
GRI	48.3	34.0	48.2	
<u>Group D</u>	17 Aug	31 Aug	6 Sep	
CAR	68.8	35.7	56.6	
FIE	62.0	29.0	35.2	
GOO	37.6	41.6	49.1	
BAR	48.2	--	--	

Table 53. Comparison of bed-rest Day 2 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Osmotic Activity, mosmol/mol creatinine	Chloride, mol/mol creatinine	Sodium, mol/mol creatinine	Potassium, mol/mol creatinine	Magnesium, mmol/mol creatinine	Calcium, mmol/mol creatinine	Phosphate, mol/mol creatinine	Total Nitrogen, g/mmol creatinine	Ammonia, mol/mol creatinine	Urea, mol/mol creatinine	Creatine, mmol/mol creatinine	Hydroxyproline, mmol/mol creatinine
Value 1-2 days before bed rest												
STE	53.2	8.8	8.9	4.92	386	397	2.27	0.71	1.71	20.3	58.3	25.3
BRO	67.4	10.6	9.8	5.10	463	470	2.84	1.04	2.04	29.9	33.0	34.0
KUB	51.1	10.3	10.7	4.28	185	203	1.77	0.83	1.46	24.8	30.2	12.5
CUT	52.1	12.9	13.1	6.06	228	238	3.07	0.87	1.65	22.4	39.0	30.9
JON	62.9	12.1	13.9	3.62	353	315	2.25	0.83	1.51	20.4	35.2	45.4
SHA	66.3	11.7	10.6	4.68	347	328	2.45	0.99	2.93	26.9	33.3	35.2
JSM	57.3	9.0	7.9	7.06	228	117	2.10	0.81	2.21	19.8	34.1	31.0
Mean	58.6	10.8	10.7	5.10	313	295	2.39	0.87	1.93	23.5	37.6	30.6
S.D.	6.9	1.6	2.2	1.14	101	120	0.44	0.11	0.52	3.9	9.5	10.1
S.E.	2.6	0.6	0.8	0.43	38	45	0.17	0.04	0.20	1.5	3.6	3.8
Value on Day 2 of bed rest												
STE	55.7	13.3	11.4	4.07	370	433	1.75	0.64	2.37	18.4	44.6	27.7
BRO	67.5	14.1	13.6	5.88	469	435	2.68	0.99	1.48	30.7	18.7	43.7
KUB	58.5	10.9	10.6	4.14	354	202	1.49	0.71	2.77	18.3	39.9	21.4
CUT	62.0	11.7	11.5	4.31	363	378	2.07	0.83	2.73	22.7	79.3	31.2
JON	57.8	13.1	9.4	5.03	283	447	2.17	0.74	1.47	16.2	37.1	32.6
SHA	69.2	14.4	14.0	5.71	163	213	1.86	0.90	2.09	22.1	3.7	30.6
JSM	54.1	11.4	12.2	5.41	101	171	1.12	0.66	0.40	15.0	32.0	22.7
Mean	60.7	12.7	11.8	4.94	300	326	1.88	0.78	1.90	20.5	36.5	30.0
S.D.	5.8	1.4	1.6	0.76	128	124	0.50	0.13	0.85	5.3	23.5	7.4
S.E.	2.2	0.5	0.6	0.29	49	47	0.19	0.05	0.32	2.0	8.9	2.8
$\bar{X}_2 - \bar{X}_1$	+2.1	+1.9	+1.1	-0.16	-13	+31	-0.51	-0.09	-0.03	-3.0	-1.1	-0.6
%	103.6	117.6	110.3	96.9	95.8	110.5	78.7	89.7	98.4	87.2	97.1	98.0
P	0.34	0.038*	0.40	0.74	0.81	0.41	0.010*	<0.001*	0.95	0.029*	0.90	0.85

Table 54. Comparison of bed-rest Day 2 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Glucose, creatinine mmol/mol	Citrate, creatinine mmol/mol	17-OHCS, creatinine mmol/mol	Epinephrine, creatinine μmol/mol	Norepinephrine, creatinine μmol/mol
<u>Value 1-2 days before bed rest</u>					
STE	31.4	429	0.83	4.06	40.5
BRO	26.5	184	1.28	5.45	46.8
KUB	17.4	145	0.70	2.43	29.5
CUT	33.0	166	1.06	7.13	44.5
JON	25.4	189	0.85	2.40	30.2
SHA	48.2	162	2.09	3.92	38.1
JSM	<u>35.3</u>	<u>131</u>	<u>1.52</u>	<u>0.72</u>	<u>30.6</u>
Mean	31.0	201	1.19	3.73	37.2
S.D.	9.6	103	0.49	2.13	7.2
S.E.	3.6	39	0.18	0.80	2.7
<u>Value on Day 2 of bed rest</u>					
STE	29.2	374	0.95	4.01	53.0
BRO	30.4	201	1.42	2.76	22.9
KUB	16.5	136	1.44	2.36	40.4
CUT	32.8	119	1.31	9.22	47.7
JON	15.9	197	1.49	3.54	25.6
SHA	40.4	170	1.62	1.48	23.8
JSM	<u>26.6</u>	<u>167</u>	<u>1.88</u>	<u>0.90</u>	<u>41.1</u>
Mean	27.4	195	1.44	3.47	36.4
S.D.	8.8	84	0.28	2.76	12.2
S.E.	3.3	32	0.11	1.04	4.6
$\bar{X}_2 - \bar{X}_1$	-3.6	-6	+0.25	-0.26	-0.8
%	88.4	97.0	121.0	92.0	97.8
P	0.11	0.65	0.14	0.71	0.88

Table 55. Comparison of bed-rest Day 6 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Osmotic Activity, mosmol/mol creatinine	Chloride, mol/mol creatinine	Sodium, mol/mol creatinine	Potassium, mol/mol creatinine	Magnesium, mmol/mol creatinine	Calcium, mmol/mol creatinine	Phosphate, mol/mol creatinine	Total Nitrogen, g/mmol creatinine	Ammonia, mol/mol creatinine	Urea, mol/mol creatinine	Creatinine, mmol/mol creatinine	Hydroxyproline, mmol/mol creatinine
<u>Value 1 day before bed rest</u>												
CUT	52.1	12.9	13.1	6.06	228	238	3.07	0.87	1.65	22.4	39.0	30.9
JON	62.9	12.1	13.9	3.62	353	315	2.25	0.83	1.51	20.4	35.2	45.4
SHA	66.3	11.7	10.6	4.68	347	328	2.45	0.99	2.93	26.9	33.3	35.2
JSM	57.3	9.0	7.9	7.06	228	117	2.10	0.81	2.21	19.8	34.1	31.0
MEI	49.7	9.8	10.1	2.55	239	145	1.23	0.70	1.85	22.6	8.9	11.5
GRI	<u>62.0</u>	<u>11.3</u>	<u>11.7</u>	<u>5.32</u>	<u>380</u>	<u>277</u>	<u>2.61</u>	<u>0.96</u>	<u>1.69</u>	<u>29.6</u>	<u>28.3</u>	<u>26.2</u>
Mean	58.4	11.1	11.2	4.88	296	237	2.29	0.86	1.97	23.6	29.8	30.0
S.D.	6.5	1.5	2.2	1.64	71	88	0.62	0.11	0.53	3.8	10.8	11.2
S.E.	2.7	0.6	0.9	0.67	29	36	0.25	0.04	0.21	1.6	4.4	4.6
<u>Value on Day 6 of bed rest</u>												
CUT	58.4	10.4	11.7	4.75	235	213	2.83	0.78	1.69	20.8	119.9	19.7
JON	50.8	10.9	11.2	4.23	212	252	2.02	0.64	1.12	15.9	29.8	14.6
SHA	74.1	11.9	11.1	5.73	340	259	2.78	1.08	2.97	33.5	85.1	27.7
JSM	59.9	12.1	10.8	7.33	249	313	2.44	0.65	1.20	15.1	44.1	23.6
MEI	47.9	8.0	9.0	2.29	200	130	1.87	0.71	1.61	23.4	179.9	15.0
GRI	<u>60.5</u>	<u>7.6</u>	<u>8.3</u>	<u>6.21</u>	<u>168</u>	<u>193</u>	<u>2.23</u>	<u>1.01</u>	<u>1.08</u>	<u>33.5</u>	<u>48.5</u>	<u>32.9</u>
Mean	58.6	10.2	10.4	5.09	234	227	2.36	0.81	1.61	23.7	84.6	22.3
S.D.	9.2	1.9	1.4	1.75	59	63	0.39	0.19	0.71	8.2	57.1	7.2
S.E.	3.7	0.8	0.6	0.72	24	26	0.16	0.08	0.29	3.3	23.3	3.0
$\bar{X}_2 - \bar{X}_1$	+0.2	-0.9	-0.8	+0.21	-62	-10	+0.07	-0.05	-0.36	+0.1	+54.8	-7.7
%	100.3	91.9	92.9	104.3	79.1	95.8	103.1	94.2	81.7	100.4	283.9	74.3
P	0.94	0.36	0.40	0.59	0.17	0.82	0.63	0.35	0.080	0.97	0.093	0.21

Table 56. Comparison of bed-rest Day 6 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Glucose, mmol/mol creatinine	Citrate, mmol/mol creatinine	17-OHCS mmol/mol creatinine	Epinephrine, μmol/mol creatinine	Norepinephrine, μmol/mol creatinine
<u>Value 1 day before bed rest</u>					
CUT.	33.0	166	1.06	7.13	44.5
JON	25.4	189	0.85	2.40	30.2
SHA	48.2	162	2.09	3.92	38.1
JSM	35.3	131	1.52	0.72	30.6
MEI	28.5	130	1.04	18.31	33.5
GRI	<u>30.3</u>	<u>160</u>	<u>0.94</u>	<u>3.89</u>	<u>48.3</u>
Mean	33.5	156	1.25	6.06	37.5
S.D.	8.0	23	0.47	6.36	7.5
S.E.	3.3	9	0.19	2.60	3.1
<u>Value on Day 6 of bed rest</u>					
CUT	26.0	145	1.40	5.27	28.4
JON	20.4	196	1.21	0.00	43.4
SHA	51.5	159	1.21	3.63	9.9
JSM	20.9	293	1.40	4.48	14.1
MEI	7.6	120	0.63	7.42	41.5
GRI	<u>30.9</u>	<u>126</u>	<u>0.91</u>	<u>0.74</u>	<u>34.0</u>
Mean	26.2	173	1.13	3.59	28.6
S.D.	14.6	65	0.30	2.80	14.0
S.E.	6.0	26	0.12	1.14	5.7
$\bar{X}_2 - \bar{X}_1$	-7.3	+17	-0.12	+2.47	-8.9
%	78.2	110.9	90.4	59.2	76.3
P	0.11	0.59	0.55	0.16	0.23

Table 57. Comparison of bed rest Day 12-13 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Osmotic Activity, mosmol/mol creatinine	Chloride, mol/mol creatinine	Sodium, mol/mol creatinine	Potassium, mol/mol creatinine	Magnesium, mmol/mol creatinine	Calcium, mmol/mol creatinine	Phosphate, mol/mol creatinine	Total Nitrogen, g/mmol creatinine	Ammonia, mol/mol creatinine	Urea, mol/mol creatinine	Creatine, mmol/mol creatinine	Hydroxyproline, mmol/mol creatinine
Value 1-2 days before bed rest												
GRI	62.0	11.3	11.7	5.32	380	277	2.61	0.96	1.69	29.6	28.3	26.2
CAR	83.0	15.8	14.1	6.76	265	224	2.44	0.96	1.68	19.1	6.7	16.7
FIE	96.3	12.1	12.2	6.53	354	284	3.11	0.86	1.91	12.1	10.4	21.9
GOO	<u>46.3</u>	<u>9.5</u>	<u>8.9</u>	<u>4.04</u>	<u>102</u>	<u>141</u>	<u>1.49</u>	<u>0.54</u>	<u>1.66</u>	<u>14.0</u>	<u>37.1</u>	<u>14.5</u>
Mean	71.9	12.2	11.7	5.66	275	232	2.41	0.83	1.74	18.7	20.6	19.8
S.D.	22.2	2.7	2.1	1.25	126	66	0.68	0.20	0.12	7.8	14.5	5.3
S.E.	11.1	1.3	1.1	0.63	63	33	0.34	0.10	0.06	3.9	7.2	2.6
Value on Day 12-13 of bed rest												
GRI	70.3	13.2	11.6	6.33	235	275	2.08	0.90	1.34	27.9	48.7	23.9
CAR	57.4	7.7	7.8	4.62	141	217	1.84	0.91	1.43	25.9	10.3	18.9
FIE	78.4	14.6	14.6	7.00	221	315	2.82	1.00	2.21	21.5	10.0	27.7
GOO	<u>59.9</u>	<u>10.1</u>	<u>10.8</u>	<u>3.83</u>	<u>240</u>	<u>264</u>	<u>2.58</u>	<u>0.87</u>	<u>1.83</u>	<u>19.2</u>	<u>11.8</u>	<u>19.8</u>
Mean	66.5	11.4	11.2	5.45	209	268	2.33	0.92	1.70	23.6	20.2	22.6
S.D.	9.7	3.1	2.8	1.47	46	40	0.45	0.06	0.40	4.0	19.0	4.1
S.E.	4.9	1.6	1.4	0.74	23	20	0.22	0.03	0.20	2.0	9.5	2.0
$\bar{X}_2 - \bar{X}_1$	-5.4	-0.8	-0.5	-0.21	-66	+36	-0.08	+0.09	-0.04	+4.9	-0.4	+2.8
%	92.5	93.4	95.7	96.3	76.0	115.5	96.7	110.8	97.7	126.2	98.1	114.1
P	0.61	0.77	0.81	0.76	0.40	0.32	0.85	0.40	0.85	0.13	0.97	0.24



Table 58. Comparison of bed rest Day 12-13 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Glucose, mmol/mol creatinine	Citrate, mmol/mol creatinine	17-OHCS, mmol/mol creatinine	Epinephrine, μmol/mol creatinine	Norepinephrine, μmol/mol creatinine
<u>Value 1-2 days before bed rest</u>					
GRI	30.3	160	0.94	3.89	48.3
CAR	41.6	217	1.46	9.41	68.8
FIE	62.5	198	1.20	15.15	62.0
GOO	<u>14.7</u>	<u>99</u>	<u>1.01</u>	<u>5.90</u>	<u>37.6</u>
Mean	37.3	169	1.15	8.59	54.2
S.D.	20.1	52	0.23	4.93	14.0
S.E.	10.1	26	0.12	2.47	7.0
<u>Value on Day 12-13 of bed rest</u>					
GRI	48.8	122	0.71	2.25	48.2
CAR	46.8	234	1.57	6.18	35.7
FIE	58.3	181	1.39	6.59	29.0
GOO	<u>41.1</u>	<u>147</u>	<u>1.30</u>	<u>4.23</u>	<u>41.6</u>
Mean	48.8	171	1.24	4.81	38.6
S.D.	7.2	48	0.37	1.99	8.2
S.E.	3.6	24	0.19	1.00	4.1
$\bar{X}_2 - \bar{X}_1$	+11.5	+2	+0.09	-3.78	-15.6
%	130.8	101.2	107.8	56.0	71.2
P	0.19	0.90	0.48	0.10	0.22

Table 59. Comparison of bed rest Day 19 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Osmotic Activity, mosmol/mol creatinine	Chloride, mol/mol creatinine	Sodium, mol/mol creatinine	Potassium, mol/mol creatinine	Magnesium, mmol/mol creatinine	Calcium, mmol/mol creatinine	Phosphate, mol/mol creatinine	Total Nitrogen, g/mmol creatinine	Ammonia, mol/mol creatinine	Urea, mol/mol creatinine	Creatine, mmol/mol creatinine	Hydroxyproline, mmol/mol creatinine
Value 2 days before bed rest												
CAR	83.0	15.8	14.1	6.76	265	224	2.44	0.96	1.68	19.1	6.7	16.7
FIE	96.3	12.1	12.2	6.53	354	284	3.11	0.86	1.91	12.1	10.4	21.9
GOO	<u>46.3</u>	<u>9.5</u>	<u>8.9</u>	<u>4.04</u>	<u>102</u>	<u>141</u>	<u>1.49</u>	<u>0.54</u>	<u>1.66</u>	<u>14.0</u>	<u>37.1</u>	<u>14.5</u>
Mean	75.2	12.5	11.7	5.78	240	216	2.35	0.79	1.75	15.1	18.1	17.7
S.D.	25.9	3.2	2.6	1.51	128	72	0.81	0.22	0.14	3.6	16.6	3.8
S.E.	15.0	1.8	1.5	0.87	74	41	0.47	0.13	0.08	2.1	9.6	2.2
Value on Day 19 of bed rest												
CAR	48.3	5.8	6.3	3.02	255	248	2.14	0.83	1.93	19.4	5.7	19.8
FIE	56.6	5.6	7.4	3.90	210	247	2.04	0.91	2.40	21.5	44.8	26.1
GOO	<u>54.7</u>	<u>8.8</u>	<u>9.4</u>	<u>3.38</u>	<u>319</u>	<u>289</u>	<u>2.25</u>	<u>0.78</u>	<u>2.25</u>	<u>24.5</u>	<u>63.0</u>	<u>22.1</u>
Mean	53.2	6.7	7.7	3.43	261	261	2.14	0.84	2.19	21.8	37.8	22.7
S.D.	4.3	1.8	1.6	0.44	55	24	0.11	0.07	0.24	2.6	29.3	3.2
S.E.	2.5	1.0	0.9	0.26	32	14	0.06	0.04	0.14	1.5	16.9	1.8
$\bar{X}_2 - \bar{X}_1$	-22.0	-5.8	-4.0	-2.35	+21	+45	-0.21	+0.05	+0.44	+6.7	+19.7	+5.0
%	70.7	53.6	65.8	59.3	108.8	120.8	91.1	106.3	125.1	144.4	208.8	128.2
P	0.28	0.17	0.24	0.12	0.86	0.50	0.74	0.67	0.048*	0.17	0.21	0.067

Table 60. Comparison of bed rest Day 19 values for various urine parameters with the base values for subjects of the 1974 NASA/Ames Time Course Bed-Rest Study.

Subject	Glucose, mmol/mol creatinine	Citrate, mmol/mol creatinine	17-OHCS, mmol/mol creatinine	Epinephrine, μmol/mol creatinine	Norepinephrine, μmol/mol creatinine
<u>Value 2 days before bed rest</u>					
CAR	41.6	217	1.46	9.41	68.8
FIE	62.5	198	1.20	15.15	62.0
G00	<u>14.7</u>	<u>99</u>	<u>1.01</u>	<u>5.90</u>	<u>37.6</u>
Mean	39.6	171	1.22	10.15	56.1
S.D.	24.0	63	0.23	4.67	16.4
S.E.	14.0	37	0.13	2.70	9.5
<u>Value on Day 19 of bed rest</u>					
CAR	27.5	229	1.23	8.26	56.6
FIE	79.2	173	0.99	4.90	35.2
G00	<u>33.8</u>	<u>125</u>	<u>1.00</u>	<u>0.75</u>	<u>49.1</u>
Mean	46.8	176	1.07	4.64	47.0
S.D.	28.2	52	0.14	3.76	10.9
S.E.	16.3	30	0.08	2.17	6.3
$\bar{X}_2 - \bar{X}_1$	+7.2	+5	-0.15	-5.51	-9.1
%	118.2	102.9	87.7	45.7	83.8
P	0.57	0.80	0.17	0.17	0.50